CHAPTER VI - APPLIED TROPICAL CYCLONE RESEARCH SUMMARY

The following articles delineate the extent of the research program at the Naval Environmental Prediction Research Facility (NAVENVPREDRSCHFAC) dedicated to supporting the operations at Joint Typhoon Warning Center (JTWC). There are three major research departments at NAVENVPREDRSCHFAC, each contributing to the overall program; research on current and future tropical cyclone models is performed in the Numerical Modeling Department, the Tactical Applications Department conducts statistical application studies, and the Satellite Processing and Display Department develops computer interactive techniques.

TROPICAL CYCLONE AIDS (TCAIDS) FOR SATELLITE-DATA PROCESSING AND DISPLAY SYSTEM (SPADS)

(Tsui, T. and A. Truschke, NAVENVPREDRSCHFAC)

TCAIDS is a system residing on SPADS composed of all existing tropical cyclone utility routines. Most of these routines use digital satellite data together with the environmental information to assist forecasters in making a low cost and timely tropical cyclone forecast. TCAIDS includes two tropical cyclone movement aids, one intensity forecasting aid, one satellite image rotation utility, and a 16-image looping display utility. The movement forecast aids are the satellite IR pattern regression routine -- ADAPT forecaster and the National Hurricane Center's Climatology-Persistence (CLIPER) routine. The intensity forecast aid uses the tropical cyclone spiral characteristics to predict the growth of the storm. This intensity forecasting program also provides various image enhancement routines.

NORTH PACIFIC TROPICAL CYCLONE CLIMATOLOGY

(Tsui, T. and R. Miller, NAVENVPREDRSCHFAC)

A tropical cyclone climatology for the North Pacific has been developed. Data used for the western basin were taken from the JTWC Tropical Cyclone Data Base and covered a period of 40 years, 1945-1984. Eastern basin data spanned the 34 year period 1949-1982 and were obtained from the Consolidated World-Wide Tropical Cyclone Data Base, National Climatic Data Center, Ashville, North Carolina. Storms for both basins were sorted according to month/day of the year into twenty-four 31-day overlapping periods. For each period, four charts are supplied: 1) actual storm paths; 2) mean storm paths; 3) average storm speed; and 4) storm constancy and frequency.

ADAPTION OF CSUM

(Tsui, T. and A. Truschke, NAVENVPREDRSCHFAC)

CSUM is a statistical tropical cyclone prediction model developed by Matsumoto and Gray (Colorado State University), and has been implemented into the JTWC combined ARQ procedure. CSUM incorporates climatology, persistence, and the Navy Operational Global Atmospheric Prediction System (NOGAPS) 500 mb height fields to forecast up to 72-hour tropical cyclone movement. In the operation, tropical cyclones are stratified on their position relative to the 500 mb subtropical ridge or their motions to better define the environmental influences on the cyclones. The 72-hour forecast track is segmented into three 24-hour time frames to permit the application of updated persistence and synoptic data relative to the new cyclone position. Testing of the optional version of the model is now underway.

ENVIRONMENTAL INFLUENCES ON TROPICAL CYCLONE INTENSIFICATION

(Merrill, R. and W. Gray, Colorado State University)

A study examining the observed upper-tropospheric environmental flow difference between intensifying and non-intensifying storms has been completed. Upper-tropospheric wind observations are composited for 28 tropical cyclones according to their intensity tendencies. A rotated coordinate system based on the outflow jet location is used so that the asymetric flow structure is preserved. Little difference is observed in total outflow on the synoptic scale. However, intensifying storms have a less constricted outflow with evidence of lateral connections with the surrounding flow.

EVALUATION OF JTWC OBJECTIVE AIDS

(Tsui, T. and R. Miller, NAVENVPREDRSCHFAC)

Evaluation of all JTWC objective aids is now underway. The complete evaluation of all aids will include 1978-1984 performances. Performances since 1967 will also be investigated; the study however will be limited to those aids existing in the JTWC data file. The evaluation will expand from the forecast error (mean vector error) to cross-track/-along-track errors, track/speed errors and timing errors. In addition, the evaluation will concentrate on the combined performance of the least forecast error distance and the most consistent heading forecast. Statistical tests on the significance of the results will be carried out to clarify the meaning of the performance differences.

NAVY TACTICAL APPLICATIONS GUIDE (NTAG) VOL. 6, PART I:
TROPICAL WEATHER ANALYSIS AND FORECAST APPLICATIONS

(Fett, R., NAVENVPREDRSCHFAC)

Studies were completed for this volume, based largely on Defense Meteorological Satellite Program (DMSP) data. The volume contains a number of new research results including a method of precisely locating the positions of equatorial troughs by satellite. Studies are presently being finalized in preparation for the printing process with anticipated distribution of Vol. 6, Part I, in the autumn of 1986. Additional studies currently under investigation in Vol. 6, Part II, relate exclusively to the tropical cyclone problem and will be published at a later date.

THE ADVANCED TROPICAL CYCLONE MODEL (ATCM)

(Hodur, R., NAVENVPREDRSCHFAC)

The Advanced Tropical Cyclone Model (ATCM) is being developed using the recommendations made at the tropical cyclone workshop held in Monterey, California (January, 1985). First, the Navy Operational Regional Atmospheric Prediction System

(NORAPS) is the framework for the ATCM. Second, the ATCM will have a uniform resolution of 80 km or less with at least 10 levels. Third, the domain of the model will cover the entire WESTPAC area. Using this approach, the ATCM will only need to be run once per watch, since all tropical systems can be included in the model domain. This also allows interactions to occur between storms during multiple storm situations.

The current work on the ATCM is geared toward defining the initial conditions of the large-scale flow and the circulation of the tropical cyclone. The large-scale flow will be defined by running the ATCM with an update cycle every watch. This approach has two advantages. First, all features forecast by ATCM are retained from one forecast to the next. Second, the first guess fields will be consistent with the ATCM model equations. Two approaches are being examined for the initial tropical cyclone circulation. The first is to allow the model to develop the storm structure in a no-flow environment, and then to add this circulation into the large-scale flow. The second is to let the model spin-up the tropical cyclone(s) with the large-scale flow using conventional data. Encouraging results were obtained using the latter technique in the western Atlantic, in the fall of 1985.

TROPICAL CYCLONE PREDICTION STUDIES

(Elsberry, R. L., Chan, J. C.-L., and J. E. Peak, NAVPGSCOL)

The performance of tropical cyclone forecast aids under different environmental conditions and for various cyclone characteristics has been studied. Based on a rating system for cross-track and along-track errors, the One-way Tropical Cyclone Model (OTCM) and the Nested Tropical Cyclone Model (NTCM) generally produce the most accurate forecasts at 72-hours. Empirical Orthogonal Function (EOF) analyses of the wind fields around western North Pacific tropical cyclones have been used to derive a statistical-synoptic track prediction scheme. The 72-hour errors are competitive with the JTWC official forecasts. Further improvement is obtained by stratifying the situations according to past storm motion. A similar improvement can be obtained if the wind-based EOF's are used to stratify the situation. An objective technique has been tested for estimating the warning position of the tropical cyclone from the fixes received during the previous 6-hours. Weighting factors for different observational platforms and for the time of the fix have been incorporated. The objective positions are generally superior to the JTWC operational positions during 1981 and 1982 and are nearly as good as the JTWC during 1983. The causes of the anomalous track guidance received during Super Typhoon Abby (1983) have also been examined. The intensity and enormous circulation of this super typhoon are suggested as the reasons for the failure of the objective aids during a period when Abby was moving almost normal to the steering flow.

THE NAVY TWO-WAY INTERACTIVE NESTED TROPICAL CYCLONE MODEL (NTCM)

(Fiorino, M., NAVENVRSCHPREDFAC)

A new version of the NTCM was tested in a research mode during the 1985 WESTPAC season. This version (NTCM3.0) has three features: 1) One-way influence boundary conditions on the course grid with forcing from the NOGAPS wind forecasts; 2) A vortex and heating specification procedure that insures a more realistic storm evolution; and 3) A pre-forecast modification of the steering flow that accounts for the observed current motion.

The operational version of the NTCM was changed in the early part of the season based on experience with NTCM3.0. The new operational version (NTCM2.2) differs from the 1984 version (NTCM2.1) in that the bias-corrector was activated and a serious program error was corrected, which affected the interaction between the fine and course meshes.

Although the time-dependent boundary version of NTCM3.0 was shown to be superior to its channel model equivalent and to NTCM2.1, the comparisons of NTCM2.2 and NTCM3.0 revealed little advantage to the new version of the model during the 1985 season.